REMARKS

Applicants have amended their claims to further define various aspects of the present invention. Specifically, each of the independent claims 3 and 7 has been amended to recite a plasma etching treatment apparatus "for conducting etching in at least two steps and without conducting a separate cleaning step." Each of claims 3 and 7 has been further amended to recite a temperature control mechanism for the substrate stage. Note, for example, page 6, lines 4-20; the paragraph bridging pages 14 and 15; and the paragraph bridging pages 11-13, particularly at page 12, lines 16-18, of Applicants' specification.

Initially, it is respectfully requested that the present amendments be entered, notwithstanding finality of the Office Action mailed January 14, 2005. In this regard, noting previous arguments made in the above-identified application, and especially noting the last four lines of previously considered claim 7, it is respectfully submitted that the present amendments do not raise any new issues, including any issue of new matter; and, moreover, it is respectfully submitted that the present amendments materially limit issues remaining in the above-identified application. As discussed infra, it is respectfully submitted that the present amendments are such that the present claims clearly patentably distinguish over the teachings of the applied prior art. Moreover, noting amplification of the rejections in the Office Action mailed January 14, 2005, it is respectfully submitted that the present amendments are clearly timely.

In view of the foregoing, it is respectfully submitted that Applicants have made the necessary showing under 37 CFR 1.116; and that, accordingly, entry of the present amendments is clearly proper notwithstanding finality of the Office Action mailed January 14, 2005.

Applicants respectfully submit that all of the claims now presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed January 14, 2005, that is, the teachings of U. S. Patent No. 5,846,373 to Pirkle, et al., and EP709877 to Saito, et al., under the provisions of 35 USC 102 and 35 USC 103.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a plasma etching treatment apparatus as in the present claims, for conducting etching in at least two steps and without conducting a separate cleaning step, and wherein the apparatus includes, inter alia, a substrate stage for placing a semiconductor substrate thereon and a temperature control mechanism for the substrate stage, and a gas introducing means for introducing (a) a treating gas for etching and (b) a treating gas for decomposing and removing etching products, the substrate being etched using plasmas obtained from each introduced treating gas in each step, together with a monitoring means for monitoring a retained amount of etching products and being controlled so as to stop each plasma discharge automatically at a time the monitored value reaches a set value. See claim 3.

In addition, it is respectfully submitted that these applied references would have neither taught nor would have suggested such plasma etching treatment apparatus as in the present claims, having features as discussed previously in connection with claim 3, and, moreover, wherein the gas introducing means includes respective sources of treating gas for decomposing and removing etching products and for etching (see claim 4); and/or wherein the apparatus further includes an electrostatic adsorption device to hold a semiconductor substrate on the substrate stage (see claim 5); and/or wherein the apparatus is adapted to discharge charges stored between the substrate stage and a semiconductor substrate place thereon

when the gas introducing means introduces the treating gas for decomposing and removing etching products (see claim 6).

Furthermore, it is respectfully submitted that the teachings of the applied references would have neither disclosed nor would have suggested such a plasma etching treating apparatus for conducting etching in at least two steps and without conducting a separate cleaning step, as in the present claims, having the substrate stage for placing a semiconductor substrate thereon and the temperature control mechanism for the substrate stage, and gas introducing means, with the gas Introducing means introducing different gas compositions in each step of the at least two steps, at least one of the gas compositions being a gas capable of decomposing and vaporizing etching products, with the substrate being etched by plasmas obtained from the different gas compositions of the at least two steps, with etching products produced by a previous etching treatment being removed without conducting a separate cleaning step. See claim 7.

To emphasize, and as recited in each of claims 3 and 7, etching is performed upon introducing each of the treating gases, and etching products produced, e.g., by a previous etching treatment (see especially claim 7) are removed without conducting a separate cleaning step.

The invention as claimed in the above-identified application relates to apparatus for effectively removing etching products retained in a treatment apparatus, providing a cleaning effect of the apparatus during the etching, without disadvantageously effecting productivity. This apparatus is especially useful in connection with recent semiconductors having higher integration, wherein circuit patterns become finer and finer to make required processing dimensional accuracy more sever; and wherein, under such circumstances, reproducibility of the processed device becomes even more important.

In such recent fine devices, it becomes more important to remove etching products (contaminants) retained in the processing chamber, these etching products being an important cause of defective semiconductor products. Various techniques have been proposed to remove such etching products, as described on pages 2 and 3 of Applicants' specification; however, such proposed techniques either do not address the problem of shift of etching ability due to retention of deposited material on the apparatus, or require substantial "downtime" (a time when the apparatus is stopped from processing substrates), which disadvantageously effects productivity. See the last paragraph on page 2, and the paragraph bridging pages 2 and 3, of Applicants' specification.

Against this background, Applicants provide etching treatment apparatus which removes etching products so as to achieve a removal of reaction products (contaminants) in the treating chamber such that the contaminant level does not exceed a predetermined amount, so that reproducibility of the etching shape is retained, while avoiding the above-mentioned "downtime"; and wherein etching rate and etching shape is uniform over the substrate surface and reproducibility of the etching is improved. Applicants have found that by utilizing apparatus including the gas introducing means as in the present claims, wherein the semiconductor substrate is etched using plasmas obtained from each introduced treating gas in each step, while the treating gas (b) removes etching products retained in the etching treatment room without conducting a separate cleaning step, and wherein temperature of the substrate stage is controlled by a temperature control mechanism forming part of the recited apparatus, the objectives according to the present invention are achieved; and, in particular, avoidance of deposition on chamber walls are avoided such that reproducibility of etching shape is retained, without

disadvantageous "downtime" which reduces productivity, and etching uniformity is improved.

In addition, Applicants have found that, in combination with the gas introducing means, through use of the monitoring means as in the present claims, treatment time can be kept to a minimum, making more efficient the processing.

Furthermore, by including the temperature control mechanism, especially together with the electrostatic adsorption device to hold a semiconductor substrate on the substrate stage, temperature control of the substrate can be conducted, particularly with thermal conductivity between the substrate stage and the substrate being enhanced, thereby enhancing uniformity of etching rate and etching shape in the substrate surface. Note, for example, the paragraph bridging pages 11-13 of Applicants' specification.

Saito, et al. discloses a plasma processing method and apparatus suitable for etching a wafer while holding the same on an electrode by electrostatic force, and using hydrogen bromide as an etching gas. This patent document discloses, according to one aspect thereof, that after completion of etching of the wafer having the same wafer as electrostatically chucked on the electrode, O_2 gas instead of the etching gas is introduced into the chamber to generate a plasma of O_2 gas, whereby not only the residual electric charge on the wafer resulting from the electrostatic attraction can be deelectrified but also cleaning of the interior of the chamber can be conducted at the same time by causing C and H which are the main components of the reaction product deposited inside the chamber to react with O_2 and to be removed. See column 2, lines 14-31. Note also column 3, lines 15-27 and 37-43; and column 4, lines 3-11.

It is respectfully submitted that Saito, et al. discloses a cleaning treatment which is conducted separately from the etching treatment, after completion of the

etching. That is, the cleaning with the O_2 plasma is not an etching treatment. It is respectfully submitted that this reference would have neither disclosed nor would have suggested, and in fact would have taught away from, the presently claimed apparatus, including wherein the gas introducing means introduces different gas compositions in each step of at least two steps, at least one of the compositions being a gas capable of decomposing and vaporizing etching products; and the semiconductor substrate is etched by using plasmas obtained from the different gas compositions of the at least two steps, with, e.g., etching products produced by a previous etching treatment being removed without conducting a separate cleaning step.

That is, while the present invention includes gas introducing means wherein the substrate is etched using plasmas obtained from the different gas compositions at the various steps, so that the apparatus is utilized without conducting a separate cleaning step, Saito, et al. requires a separate cleaning step using the O_2 gas therein.

In addition, it is respectfully submitted that Saito, et al. would have neither taught nor would have suggested the temperature control mechanism for the substrate stage as in the present claims, and advantages thereof as discussed in the foregoing. Note each of claims 3 and 7.

It is respectfully submitted that the additional teachings of Pirkle, et al. would not have rectified the deficiencies of Saito, et al., such that the presently claimed invention as a whole would have been obvious to one of ordinary skill in the art.

Pirkle, et al. discloses methods and arrangements for monitoring silicon dioxide deposition and in-situ cleaning process endpoints in plasma chambers, wherein an SiO_2 deposition is performed on a semiconductor substrate; and an

in-situ cleaning process is performed on the plasma chamber, subsequent to the SiO_2 deposition, the in-situ cleaning process including steps of generating a fluorine-containing etching plasma in the plasma chamber so that the etching plasma reacts with SiO_2 in the plasma chamber to form a plurality of reaction products; filtering light emissions from the plasma chamber with a wavelength selective element so that one of the reaction products having a characteristic wavelength proximate the peak transmission of the wavelength selective element is transmitted through the wavelength selective element, monitoring, with a photodetector, emission intensity of light emitted by one of the reaction products; measuring voltage output from the photodetector, the voltage output being proportional to the amount of the reaction product in the etching plasma; and stopping generation of the etching plasma when voltage measurements decrease to a substantially steady state value. Note column 2, lines 22-56. See also column 3, lines 26-51, in connection with the described apparatus. Note also column 4, lines 41-45.

Even assuming, arguendo, that the teachings of Saito, et al. and Pirkle, et al. were properly combinable, it is respectfully submitted that the combined teachings of these references would have neither disclosed nor would have suggested the gas introducing means, and particularly wherein the semiconductor substrate is etched using plasmas obtained from each introduced treating gas in each step, while the treating gas (b) removes etching products retained in the etching treatment room without conducting a separate cleaning step, especially where etching products from a previous etching treatment are removed without a separate cleaning step; and/or the monitoring means for monitoring a retained amount of etching products and being controlled so as to stop each plasma discharge automatically at the recited time, as in claim 3; and/or the temperature control mechanism for the substrate stage, as in all of the claims.

It is noted that Pirkle, et al. uses a wavelength selective device for monitoring the deposition and cleaning process; but it is respectfully submitted that this reference does not disclose, nor would have suggested, either by itself or in combination with the teachings of Saito, et al., controlling the monitoring means so as to stop each plasma discharge automatically as in the present claims.

It is emphasized that Pirkle, et al. discloses a monitoring system, including, inter alia, temperature monitoring equipment 28 attached to temperature probe 29 (note Fig. 1B). It is respectfully submitted that disclosure of such monitoring equipment would have neither disclosed nor would have suggested the temperature control mechanism for the substrate stage as in the present invention, including advantages of the temperature control mechanism of the present invention as discussed previously.

Furthermore, as described in Pirkle, et al., and consistent with the teachings of Saito, et al., a separate cleaning step is required. It is respectfully submitted that the combined teachings of Saito, et al. and of Pirkle, et al. would have neither taught nor would have suggested, and in fact would have taught away from, the presently claimed apparatus for conducting etching in at least two steps and without conducting a separate cleaning step, including, inter alia, the gas introducing means for introducing the respective treating gases for etching and for decomposing and removing etching products, with the substrate being etched using plasmas obtained from each introduced treating gas in each step (see claim 3); and/or wherein the gas introducing means introduces different gas compositions in each step of the at least two steps, the semiconductor substrate being etched by plasmas obtained from the different gas compositions of the at least two steps, with etching products produced by a previous etching treatment being removed without a separate cleaning step (see claim 7).

It is emphasized that the present claims recite gas introducing means for introducing treating gas. It is respectfully submitted that this means (plus function) must be considered in determining patentability of the present claims. See 35 USC 112, 6th paragraph.

In view of the foregoing comments and amendments, entry of the present amendments, and reconsideration and allowance of all claims presently in the application, are respectfully requested.

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Respectfully submitted,

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